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(54) Papermaker's felt incorporating a closed cell polymeric foam layer.

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Description

Papermaker's felts are used in the press section of a papermaking machine to extract water from the wet paper web. The paper web is supported on the felt and passes through the nip between a pair of cooperating press rolls to extract water from the web. It is recognized that when the felt and supported paper web are released from the nip, the felt and paper will tend to expand to their original thickness and this expansion sets up hydraulic and capilliary forces, which tends to draw water from the felt back into the paper web, a phenomenon commonly referred to as "reweting".

It has been proposed in the past to incorporate a layer of open cell polymeric foam as a component of a papermaker's felt. For example, U.S. Patent 3,059,312, discloses a papermaker's felt composed of a base fabric, and a layer of an open cell polymeric foam sandwiched between the base fabric and an outer fibrous batt. The batt is then needled to the base fabric to provide the felt structure.

U.S. patent 3,617,442, is directed to a structure to be used as a papermaker's felt or a forming wire, in which the endless structure is composed solely of an open cell polymeric material. When used as a forming wire, the polymeric material can also be reinforced by internal machine direction yarns.

The prior felt constructions incorporating a polymeric foam layer, have utilized an open cell foam, in which the cells or pores are interconnected to provide a water permeable structure. Closed cell polymeric foam has not been recognized as a viable component in a papermaker's felt because the foam is substantially impervious to the flow of fluids. This is true even though open cell foam is considerably more expensive than closed cell foam due to the fact that open cell foam is produced by costly chemical and/or mechanical reticulating processes.

US-PS 4 369 081 shows a method of producing a felt in which a layer of fibrous batt is needled into the foam and base fabric, but it does not show or suggest the use of a closed cell foam as in the invention. As noted on page 2 of this application, closed cell foam has not been recognized as a component for a papermaker's felt because the closed cell foam is substantially impervious to the flow of fluids. This is true even though open cell foam is considerably more expensive than closed cell foam. As further noted on the bottom of page 5 and the top of page 6, open cell foam is considerably more expensive to produce than closed cell foam in that the foam is initially formed in the closed cell condition and it is then necessary to reticulate the closed cell construction, either by chemical or mechanical processes, to provide the open cell construction.

It is the purpose of the invention to propose a papermaker's felt having a felt structure which resists the hydraulic and capillary forces tending to draw water back into the paper web, thereby minimizing rewetting of the paper web. Further, it is the purpose of the invention to propose a method of making such felt, as well as a method of dewatering a wet paper web. These purposes are achieved by the characterizing portions of claims 1 respectively 8 respectively 12.

The closed cell foam, such as polyurethane foam, is composed of a multiplicity of isolated, closed cells. During fabrication of the closed cell foam material, and subsequent handling, some of the cell walls may be ruptured. However, the foam material, before being incorporated into the felt structure, has a very low air permeability During the needling process, the fibers of the batt are penetrated into the foam material, in a uniform pattern so that the penetrated fibers intersect the cells and rupture the cell walls. However, due to the resiliency of the foam material, the foam will close upon the penetrated fibers so that the resulting felt structure, under static or uncompressed conditions will have a low air permeability.

In use, when the felt carrying the wet paper web passes through the nip between cooperating press rolls, water is extracted from the paper web and the compressive force will open the interfaces between the penetrated fibers and the foam to permit the water to be discharged through the felt structure. On release from the nip, the felt and paper web will expand, and the resiliency of the foam will close off the interfaces between the penetrated fibers and the cell walls to trap water in the cells and resist the hydraulic and capillary forces tending to draw water back into the paper web, thereby minimizing rewetting of the paper web.

As a further advantage, the needled felt of the invention has a more uniform permeability throughout its area than a conventional felt, thereby resulting in more uniform water extraction characteristics.

Other objects and advantages will appear in the course of the following description.

Description of the Preferred Embodiment

The papermakers felt of the invention comprises a base fabric, a layer of closed cell polymeric material, and a batt of fibrous material which is needled to the base fabric and foam layer.

The base fabric is preferably a woven material formed of machine direction yarns and cross yarns. The machine direction and cross yarns can be formed of monofiliments, multifiliments, or staple yarns and consist of synthetic or natural fibers or

mixtures thereof.

The fibrous batt comprises a mass of synthetic or natural fibers.

The closed cell foam layer can be formed from a material, such as polyurethane and prior to its assembly in the felt structure has a density of 16 - 97 kg/m^3 (1.0 to 6.0 lbs per cubic foot), a thickness of 1,25 - 12,5 mm (50 to 500 mils) and a rigidity of 35-150 IFD (Internal Force Deflection) and an air permeabilty of 0,3 - 3,9 m^3 per m^2 (10 to 130 cubic feet per square foot) of fabric per minute as determined by the standard air permeability test procedure ASTM-D-737-46.

The foam layer has a multiplicity of small isolated cells. However, the chemical reactions that form the foam cells may result in some cell walls being broken, and in handling the foam, i.e. foam peeling and rolling, additional cell walls may be broken so that in practice the foam layer will have a very low air permeability within the above mentioned range, but the permeability will not be uniform throughout its area due to the cell rupturing occurring at isolated locations.

The needling operation is conventional and acts to penetrate the fibers of the batt into the foam layer and base fabric. The needled felt will contain in the range of 138 to 316 needle penetrations per mm (3500 to 5500 per inch).

The base fabric can either be produced in endless form or can be a pin seamed fabric in which the ends the base fabric are provided with a plurality of interdigitated loops which are connected by a removable pin or pintle.

In the preferred form of the invention, the foam layer is disposed on a surface of the endless base fabric. The composite endless structure, consisting of the base fabric and the foam layer, is then placed in a conventional needling machine and the fibrous batt material is needled into the foam and base layer.

While the above description has described a construction in which the foam layer is sandwiched between the base fabric and the fibrous batt, the relationship of the components is not critical. In other applications, fibrous batts may be needled into both faces of the felt structure or the batt can be sandwiched between the foam layer and the base layer. In further applications the foam layer may be sandwiched between a pair of base fabrics and batts needled to one or both faces of the structure.

In the past, open cell polymeric foam has been incorporated in papermakers felt. However, open cell foam is considerably more expensive to produce than closed cell foam in that the polymeric foam is formed in a closed cell condition and it is then necessary to reticulate the closed cell construction, either by chemical or mechanical processes, to provide the open cell construction. Therefore, even though closed cell foam is considerably less expensive than open cell foam, it was heretofore believed that closed cell foam was not a viable component for a papermakers felt due to its imperious nature. Quite unexpectedly, it has been discovered through the invention that the more inexpensive closed cell foam can be incorporated into a felt structure and will provide the necessary permeability for the felt. In the needling operation, the needles break the cell walls and drive the fibers into the foam structure. The resiliency of the polymeric material acts to close the cell walls against the penetrated fibers so that under static, uncompressed conditions the imperious nature of the foam is retained after needling. However, under dynamic conditions as the felt passes through the nip between the press rolls, the compressive force of tile nip will open the interfaces between the cell walls and the penetrated fibers to enable water to be driven through the felt. After the felt passes through the nip, the foam will expand to its original condition in which the interfaces are substantially closed, thereby trapping water in the cells and minimizing the amount of water being drawn by hydraulic and capillary forces back to the paper web. Thus, the needled closed cell foam layer acts as a one-way valve, permitting the flow of water from the paper web under compressive conditions, but substantially preventing the flow of water back to the paper web under non-compressive conditions.

Moreover, the needling operation provides more uniform water extraction characteristics for the felt throughout its length so that the paper web is dried more uniformly.

Claims

1. A papermakers felt, comprising a layer of resilient polymeric foam containing a multiplicity of isolated cells, and a fibrous material needled to said foam layer and including a multiplicity of fibers penetrated into said foam layer and intersecting said cells, characterized in that the resilient polymeric foam comprises closed cells.

2. The felt of claim 1, wherein said foam prior to needling has a density of 16 - 97 kg/m^3 (1.0 to 6.0 lbs) per cubic foot, a thickness of 1,25 - 12,5 mm (50 to 500 mils), a rigidity of 35 to 150 IFD and an air permeability of 0,3 - 3,9 m^3 per m^2 (10 to 130 cubic feet per square foot) of fabric per minute.

3. The felt of claim 1, wherein said felt has an air permeability of 0,3 - 4,5 m^3 per m^2 (10 to 150

cubic feet per square foot) of fabric per minute.

4. The felt of claim 1, wherein said needled felt contains 138 to 216 needle penetrations per mm (3500 to 5500 per inch).

5. The felt of claim 1, comprising a base fabric, and a fibrous batt needled to said foam layer and to said base fabric to provide a felt structure, said needled felt structure having from 138 to 216 needle penetrations per mm (3500 to 5500 per inch).

6. The felt of claim 1, wherein the layer of closed cell polymeric foam contains a multiplicity of non-connected cells bordered by cell walls, and a multiplicity of randomly oriented fibers penetrated into said foam layer and intersecting said cell walls, said foam layer prior to penetration of said fibers having a density in the range of 16 to 97 kg/m^3 (1.0 to 6.0 lbs per cubic foot), a thickness of 1,25 - 12,5 mm (50 to 500 mils), a rigidity of 35 to 150 IFD, and an air permeability of 0,3 - 3,9 m^3 per m^2 (10 to 130 to cubic feet per square foot) of fabric per minute.

7. The felt of claim 6, wherein the interfaces between said foam and the penetrated fibers under non-compressed conditions of said felt are in substantially sealed relation to substantially prevent liquid flow through said foam layer, and said interfaces under compressed conditions of said felt are opened to permit liquid flow through said foam layer.

8. A method of making a papermakers felt, characterized by the steps of preparing a layer of closed cell polymeric foam containing a multiplicity of isolated cells bordered by closed cell walls, and penetrating a multiplicity of fibers into said foam layer and through said cell walls to produce a water permeable felt structure under compressed conditions of said felt.

9. The method of claim 8, wherein said step of penetrating comprises needling a fibrous batt to said foam layer.

10. The method of claim 8, and including the step of positioning a base fabric in juxtaposition to said foam layer, and penetrating said fibers into both said foam layer and said base fabric.

11. The method of claim 9, wherein said step of needling includes from 5,4 to 8,5 needle penetrations per square mm of felt surface(3500 - 5500 per square inch).

12. A method of dewatering a wet paper web, characterized by the steps of forming a felt by penetrating a multiplicity of fibers into a layer of resilient closed cell polymeric foam and closing said polymeric material around said penetrated fibers to maintain said foam layer substantially imperious under non-compressed conditions, disposing a wet paper web in flatwise contact with a surface of said felt, subjecting said felt and said paper web to a compressive force to cause said polymeric material to separate from said penetrated fibers and permit the flow of water from said paper web through said foam layer.

13. The method of claim 12, and including the step of releasing said compressive force to close said polymeric material around said penetrated fibers and restrict the flow of water in a direction from said felt to said paper web.

Patentansprüche

1. Papiermacherfilz mit einer Lage aus elastischem polymeren Schaum, enthaltend eine Vielzahl von isolierten Zellen, und ein Fasermaterial, das auf die Schaumlage aufgenadelt wird und eine Mehrzahl von Fasern aufweist, die in die Schaumlage eindringen und Zellen durchschneiden, dadurch gekennzeichnet, daß der elastische polymere Schaum geschlossene Zellen umfaßt.

2. Filz nach Anspruch 1, wobei der Schaum vor dem Nadeln eine Dichte von 16 - 97 kg/m^3 aufweist, eine Stärke von 1,25 - 12.5 mm, eine Steifigkeit von 35 - 1150 IFD sowie eine Luftdurchlässigkeit von 0,3 - 3,9 m^3 pro m^2 des Gewebes pro Minute.

3. Filz nach Anspruch 1, wobei der Filz eine Luftdurchlässigkeit von 0,3 bis 4,5 m^3 pro m^2 Filz pro Minute aufweist.

4. Filz nach Anspruch 1, wobei der genadelte Filz 138 - 216 Nadelpenetrationen pro mm aufweist.

5. Filz nach Anspruch 1, umfassend ein Basisgewebe sowie eine Faserschicht, die auf die Schaumlage und das Basisgewebe aufgenadelt ist, um eine Filzstruktur zu schaffen, wobei die genadelte Filzstruktur zwischen 138 und 216 Nadelpenetrationen pro mm aufweist.

6. Filz nach Anspruch 1, wobei die Lage aus geschlossenzelligem polymeren Schaum eine Mehrzahl von nicht miteinander verbundener Zellen umfaßt, die von Zellwänden begrenzt ist, und eine Mehrzahl von zufällig orientierten Fasern, die in die Schaumlage eingedrungen sind und die Zellwände schneiden, wobei die Schaumlage vor dem Eindringen der Fasern eine Dichte im Bereich von 16 bis 97 kg/m^3 aufweist, eine Stärke von 1,25 - 12,5 mm, eine Steifigkeit von 35 bis 150 IFD und eine Luftdurchlässigkeit von 0,3 - 3,9 m^3 pro m^2 des Gewebes pro Minute.

7. Filz nach Anspruch 6, wobei die Zwischenflächen zwischen dem Schaum und den eingedrungenen Fasern im nicht komprimierten Zustand des Filzes im wesentlichen abgesperrt sind, um Flüssigkeitsströmung durch die Schaumlage im wesentlichen zu unterbinden, und wobei die Zwischenflächen im komprimierten Zustand des Filzes geöffnet sind, um Flüssigkeitsströmung durch die Schaumlage zu erlauben.

8. Verfahren zum Herstellen eines Papiermacherfilzes, gekennzeichnet durch die Schritte des Herstellens einer Lage aus geschlossenzelligem polymeren Schaum, enthaltend eine Mehrzahl von isolierten Zellen, die begrenzt sind durch geschlossene Zellwände, und durch Eindringenlassen der Mehrzahl von Fasern in die Schaumlage sowie durch die Zellenwände, um eine im komprimierten Zustand des Filzes wasserdurchlässige Filzstruktur zu schaffen.

9. Verfahren nach Anspruch 8, wobei der Schritt des Penetrierens das Nadeln einer Faserschicht auf die Schaumlage umfaßt.

10. Verfahren nach Anspruch 8, umfassend den Schritt des Positionierens eines Basisgewebes gegenüber einer Schaumlage, und des Penetrierens der Fasern in die Schaumlage und in das Basisgewebe.

11. Verfahren nach Anspruch 9, wobei der Schritt des Nadelns zwischen 5,4 und 8,5 Nadelpenetrationen pro mm Filzfläche aufweist.

12. Verfahren zum Entwässern einer nassen Papierbahn, gekennzeichnet durch die Schritte des Bildens eines Filzes durch Penetrieren einer Vielzahl von Fasern in eine Lage aus elastischem, geschlossenzelligen polymeren Schaum und durch Schließen des polymeren Materiales rund um die penetrierten Fasern, um die Schaumlage im nicht komprimierten Zustand im wesentlichen undurchlässig zu halten, durch Anordnen einer nassen Papierbahn in flachem Kontakt mit der Fläche des Filzes, und durch Unterwerfen des Filzes und der Papierbahn einer Druckkraft, um das polymere Material dazu zu veranlassen, sich von den penetrierten Fasern zu trennen und um eine Strömung von Wasser aus der Papierbahn durch die Schaumlage zu erlauben.

13. Verfahren nach Anspruch 12, enthaltend den Schritt des Freigebens der Druckkraft, um das polymere Material rund um die penetrierten Fasern zu schließen und die Strömung von Wasser in Richtung aus dem Filz zur Papierbahn zu behindern.

Revendications

1. Feutre pour papeterie comportant une couche de mousse polymère élastique contenant une pluralité de cellules isolées, et un matériau fibreux cousu à la couche de mousse et comportant une pluralité de fibres qui pénètrent dans la couche de mousse et sont en intersection avec les cellules, caractérisé en ce que la couche de mousse polymère élastique comporte des cellules fermées.

2. Feutre selon la revendication 1, caractérisé en ce qu'avant la couture la mousse a une densité de 16 à 97 kg/m^3 (1.0 à 6.0 lbs par pied cubique), une épaisseur de 1,25 à 12,5 mm (50 à 500 mils), une rigidité de 35 à 150 IFD et une perméabilité à l'air de 0,3 à 3,9 m^3 par m^2 (10 à 130 pieds cubiques par pied carré de tissu par minute.

3. Feutre selon la revendication 1, caractérisé en ce qu'il a une perméabilité à l'air de 0,3 à 4,5 m^3 par m^2 (10 à 150 pieds cubiques par pied carré) de tissu par minute.

4. Feutre selon la revendication 1, caractérisé en ce que le feutre cousu contient 138 à 216 pénétrations d'aiguille par mm (3 500 à 5 500 par pouce).

5. Feutre selon la revendication 1, comportant un tissu de base et un coton fibreux cousu à la couche de mousse et au tissu de base pour procurer une structure de feutre, la structure de feutre cousue ayant entre 138 et 216 pénétrations d'aiguille par mm (3 500 à 5 500 par pouce).

6. Feutre selon la revendication 1, caractérisé en ce que la couche de mousse polymère à cellu-

le fermée contient une multiplicité de cellules non connectées délimitées par des parois de cellules, et une multiplicité de libres orientées de manière aléatoire qui pénètrent dans la couche de mousse et sont en intersection avec les parois de cellules, la couche de mousse ayant avant la pénétration des fibres une densité dans la fourchette de 16 à 97 kg/m^3 (1.0 à 6.0 lbs par pied cubique), une épaisseur de 1,25 à 12,5 mm (50 à 500 mils), une rigidité de 35 à 150 IFD, et une perméabilité à l'air de 0,3 à 3,9 m^3 par m^2 (10 à 130 pieds cubiques par pied carré) de tissu par minute.

7. Feutre selon la revendication 6, caractérisé en ce que les interfaces entre la mousse et les fibres qui ont pénétré lorsque le feutre n'est pas comprimé sont substantiellement en relation étanche pour substantiellement empêcher un écoulement de liquide à travers la couche de mousse, et les interfaces lorsque le feutre est comprimé sont ouverts pour permettre un écoulement de liquide à travers la couche de mousse.

8. Procédé de fabrication d'un feutre pour papeterie, caractérisé par les étapes suivantes : préparation d'une couche de mousse polymère à cellules fermées contenant une pluralité de cellules isolées délimitées par des parois de cellules fermées, et pénétration d'une pluralité de libres dans la couche de mousse et à travers les parois de cellules pour procurer une structure de feutre perméable à l'eau lorsque le feutre est comprimé.

9. Procédé selon la revendication 8, caractérisé en ce que l'étape de pénétration comporte la couture d'un coton fibreux sur la couche de mousse.

10. Procédé selon la revendication 8, comportant une étape de positionnement d'une structure de base en juxtaposition avec la couche de mousse, et la pénétration des libres à la fois dans la couche de mousse et dans la structure de base.

11. Procédé selon la revendication 9, caractérisé en ce que l'étape de couture comporte entre 5,4 et 8,5 pénétrations d'aiguille par mm^2 de surface de feutre (3 500 à 5 500 par pouce carré).

12. Procédé de déshumidification de toile de papier humide, caractérisé par les étapes de formation d'un feutre par pénétration d'une pluralité de fibres dans une couche de mousse polymère à cellule fermée élastique et fermeture du matériau polymère autour des fibres qui l'ont pénétré pour maintenir la couche de mousse de façon impérative lorsqu'elle n'est pas comprimée, disposition d'une toile de papier humide en contact plat avec la surface de feutre, assujettissement du feutre et de la toile de papier à une force de compression pour provoquer la séparation du matériau polymère et des fibres ayant pénétrées et ainsi permettre l'écoulement de l'eau à partir de la toile de papier à travers la couche de mousse.

13. Procédé selon la revendication 12, comportant l'étape de relâchement de la force de compression pour fermer le matériau polymère autour des fibres ayant pénétrées et restreindre l'écoulement de l'eau dans une direction à partir du feutre vers la toile de papier.